In re Patent Application of:
ISAKSSON ET AL.
Serial No. **09/147,750**
Filing Date: **MAY 28, 1999**

In the Claims:

1. (Currently Amended) A multi-carrier transmission system comprising a first and a second transceiver, each of said transceivers having a receiver and a transmitter, wherein data is transmitted between said transceivers by modulating said data onto a multiplicity of carrier waves in the form of multi-bit symbols, wherein each carrier wave constitutes a channel, and wherein the number of bits per symbol ~~symbol, (the bit loading),~~ varies between channels and, within a channel, with time, so that each channel has associated therewith a bit loading parameter, characterized in that, in operation, said multi-carrier system is adapted to synchronously update, at said first and second transceivers, the bit loading parameters associated with each channel by transmission of data over a control channel, in that said control channel is established, at system ~~start up,~~ start-up that includes activation of said multi-carrier system, on a predetermined one of said multiplicity of carrier waves whose identity is known to said first and second transceivers, said first and second transceivers for performing the following

booting said transmitter and continuously transmitting frames in which all carrier waves other than said predetermined wave are modulated with random data, said transmitter also transmitting a system heartbeat,

booting said receiver and initiating channel equalization, synchronizing clocks in said first and second transceivers, and establishing said control channel on said predetermined carrier wave on receipt of the system heartbeat,

transferring said control channel to a carrier wave selected by said multi-carrier system and enabling bit loading control, and

enabling all carrier waves, and in that said control channel is, after start-up, changed from said predetermined channel to a further channel, selected by said first transceiver on the basis of channel characteristics.

2. (Previously Presented) A multi-carrier transmission system, as claimed in claim 1, characterized in that decisions relating to changes in bit loading and control channel selection are initiated by said first transceiver transmitting command signals over said control channel, in that said second transceiver effects changes in bit loading and control channel carrier wave selection, and in that said second transceiver measures changes in channel characteristics and forwards data relating thereto over said control channel to said first transceiver.

3. (Previously Presented) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multi-carrier transmission system is a DMT transmission system.

4. (Previously Presented) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multicarrier transmission system is a DMT-based VDSL system.

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5. (Previously Presented) A multi-carrier transmission system, as claimed in claim 1, characterized in that said multicarrier transmission system is a DMT-based ADSL system.

6. (Previously Presented) A multi-carrier transmission system, as claimed in claim 3, characterized in that said predetermined carrier wave is selected from said multiplicity of carrier waves on the basis of channel SNR characteristics so that said control channel is subject to minimal interference from noise.

Claims 7-8 (Canceled).

9. (Currently Amended) A multi-carrier system, as claimed in ~~claim 8,~~ claim 1, characterized in that said step of transferring said control channel includes, in said first transceiver:

receiving data, by the transmitter, relating to measured channel characteristics from receivers in both said first and second transceivers;

selecting a carrier wave to which said control channel is to be reallocated by said transmitter;

transmitting, by said transmitter, a signal identifying said carrier wave, to which said control channel is to be reallocated, to said second transceiver;

on receipt of a confirmation signal, from said second transceiver, said transmitter terminating said control channel on said predetermined carrier wave;

said transmitter starting said control channel on

the reallocated carrier wave at a heartbeat;

said receiver measuring channel characteristics and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver equalizing said measured channel;

said receiver obtaining a channel estimation from the second transceiver and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver receiving data identifying the carrier wave for reallocation of said control channel;

said receiver receiving a confirmation signal from said second transceiver;

said receiver terminating the control channel on said predetermined carrier wave;

said receiver establishing the control channel on the reallocated carrier wave; and

if said control channel cannot be established, returning to said step of establishing said control channel.

10. (Currently Amended) A multi-carrier system as claimed in ~~claim 7,~~ claim 1, characterized in that said step of enabling all carrier waves includes, on a continuous basis, in said first transceiver:

said transmitter obtaining data relating to measured channels from receivers in both said transceivers;

said transmitter determining the bit loading parameter for each carrier wave;

said transmitter transmitting data relating to the bit loading parameter to said second transceiver;

said transmitter changing the bit loading parameter

on confirmation from said second transceiver;

the receiver measuring the channel characteristics of said multiplicity of channels and sending data relating to said measurements to said transmitter;

the receiver equalizing said multiplicity of channels in accordance with said measured channel characteristics;

the receiver obtaining a channel estimation from said second transceiver for each of said multiplicity of channels;

the receiver obtaining a new bit loading parameter for each of said multiplicity of channels;

the receiver obtaining a confirmation signal from said second transceiver;

the receiver updating the bit loading parameters for each of the multiplicity of channels.

11. (Previously Presented) A multi-carrier transmission system, as claimed in claim 1, characterized in that channel characteristics are estimated by periodic transmission, by one of said transceivers, of a base sync frame having a predetermined content and comparing, in the other of said transceivers, the received base sync frame with a reference frame.

12. (Previously Presented) A multi-carrier transmission system, as claimed in claim 11, characterized in that said channel characteristics include attenuation, phase shifting and variance.

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13. (Previously Presented) A multi-carrier transmission system, as claimed in claim 11, characterized in that said base sync frames are transmitted at base sync intervals (BSI), and said BSI is locked into said transceivers thereby enabling said transceivers to identify a frame as a sync frame.

14. (Previously Presented) A multi-carrier transmission system, as claimed in claim 13, characterized in that additional sync frames are transmitted at intervals between said base sync frames.

15. (Previously Presented) A multi-carrier transmission system, as claimed in claim 13, characterized in that said first transceiver issues commands for system reconfiguration at the start of the BSI, and in that system reconfiguration is effected at the start of the next BSI.

16. (Previously Presented) A multi-carrier transmission system, as claimed in claim 13, characterized in that said BSI is greater than twice a system transit time for the multi-carrier transmission system.

17. (Currently Amended) In a multi-carrier transmission system having a first and a second transceiver, each of said transceivers having a receiver and a transmitter, wherein data is transmitted between said transceivers by modulating said data onto a multiplicity of carrier waves in the form of multi-bit symbols, wherein each of said carrier waves constitutes a channel, and wherein the number of bits

per symbol, (the bit loading), varies between channels and, within a channel, with time, so that each channel has associated therewith a bit loading parameter, a method of operating a control channel characterized by:

synchronously updating, at said first and second transceivers, the bit loading parameters associated with each channel by transmission of data over the control channel;

establishing said control channel, at system ~~start-up,~~ start-up that includes activation of said multi-carrier system, on a predetermined one of said multiplicity of carrier waves whose identity is known to said first and second ~~transceivers; and~~ transceivers, and comprising

booting said transmitter and continuously transmitting frames in which all carrier waves other than said predetermined wave are modulated with random data, said transmitter also transmitting a system heartbeat,

booting said receiver and initiating channel equalization, synchronizing clocks in said first and second transceivers, and establishing said control channel on said predetermined carrier wave on receipt of the system heartbeat,

transferring said control channel to a carrier wave selected by said multi-carrier system and enabling bit loading control, and

enabling all carrier waves; and

after start-up, changing said control channel from said predetermined channel to a further channel, selected by said first transceiver on the basis of channel characteristics.

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18. (Previously Presented) A method, as claimed in claim 17, characterized by:

initiating decisions, relating to changes in bit loading and control channel selection, in said first transceiver and transmitting command signals over said control channel;

effecting changes in bit loading and control channel carrier wave selection in said second transceiver; and

in said second transceiver, measuring changes in channel characteristics and forwarding data relating thereto over said control channel to said first transceiver.

19. (Previously Presented) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT transmission system.

20. (Previously Presented) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT-based VDSL system.

21. (Previously Presented) A method, as claimed in claim 17, characterized in that said multi-carrier transmission system is a DMT-based ADSL system.

22. (Previously Presented) A method, as claimed in claim 19, characterized by selecting said predetermined carrier wave from said multiplicity of carrier waves on the basis of channel SNR characteristics so that said control channel is subject to minimal interference from noise.

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Claims 23-24 (Canceled).

25. (Currently Amended) A method, as claimed in ~~claim 24,~~ claim 17, characterized by said step of transferring said control channel including, in said first transceiver:

receiving data, by the transmitter, relating to measured channel characteristics from receivers in both said first and second transceivers;

selecting a carrier wave to which said control channel is to be reallocated by said transmitter;

transmitting, by said transmitter, a signal identifying said carrier wave, to which said control channel is to be reallocated, to said second transceiver;

on receipt of a confirmation signal, from said second transceiver, said transmitter terminating said control channel on said predetermined carrier wave;

said transmitter starting said control channel on the reallocated carrier wave at a heartbeat;

said receiver measuring channel characteristics and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver equalizing said measured channel; said receiver obtaining a channel estimation from the second transceiver and transmitting data relating thereto to said transmitter in said first transceiver;

said receiver receiving data identifying the carrier wave for reallocation of said control channel;

said receiver receiving a confirmation signal from said second transceiver;

said receiver terminating the control channel on said predetermined carrier wave;

said receiver establishing the control channel on the reallocated carrier wave; and

if said control channel cannot be established, returning to said step of establishing said control channel.

26. (Currently Amended) A method, as claimed in ~~claim 23,~~ claim 17, characterized by said step of enabling all carrier waves including, on a continuous basis, in said first transceiver:

said transmitter obtaining data relating to measured channels from receivers in both said transceivers;

said transmitter determining the bit loading parameter for each carrier wave;

said transmitter transmitting data relating to the bit loading parameter to said second transceiver;

said transmitter changing the bit loading parameter on confirmation from said second transceiver;

the receiver measuring the channel characteristics of said multiplicity of channels and sending data relating to said measurements to said transmitter;

the receiver equalizing said multiplicity of channels in accordance with said measured channel characteristics;

the receiver obtaining a channel estimation from said second transceiver for each of said multiplicity of channels;

the receiver obtaining a new bit loading parameter for each of said multiplicity of channels;

the receiver obtaining a confirmation signal from said second transceiver;

the receiver updating the bit loading parameters for each of the multiplicity of channels.

27. (Previously Presented) A method, as claimed in claim 17, characterized by estimating channel characteristics by periodic transmission, by one of said transceivers, of a base sync frame having a predetermined content and comparing, in the other of said transceivers, the received sync frame with a reference frame.

28. (Previously Presented) A method, as claimed in claim 27, characterized by said channel characteristics including attenuation, phase shifting and variance.

29. (Previously Presented) A method, as claimed in claim 27, characterized by transmitting said base sync frames at base sync intervals (BSI), and locking said BSI into said transceivers thereby enabling said transceivers to identify a frame as a sync frame.

30. (Previously Presented) A method, as claimed in claim 29, characterized by transmitting additional sync frames at intervals between said base sync frames.

31. (Previously Presented) A method, as claimed in claim 29, characterized by said first transceiver issuing commands for system reconfiguration at the start of the BSI and effecting system reconfiguration at the start of the next

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BSI.

32. (Previously Presented) A method, as claimed in claim 29, characterized in that said BSI is greater than twice a system transit time for the multi-carrier transmission system.

Claims 33-35 (Canceled).

Claims 36-45 (Canceled).